DIVERSITY OF CEPHALOPODA FROM THE WATERS AROUND TAIWAN

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ABSTRACT

Based on a new collection of cephalopods made during the period January 1995 to date, the list of cephalopods known to occur in Taiwanese waters, including the Taiwan Strait, has increased from 32 species to 64 species, belonging to 28 genera, 14 families, including several species of sepiids and octopods new to science. The most speciose families are the family Sepiidae with 15 species, Loliginidae with 7 species, and Octopodidae with 22 species. The fauna is largely in common with that of the neighbouring areas of the East China Sea and the South China Sea. When comparing the present result with previous reports, it is evident that the proportion of newly recorded taxa is large. At least 30 out of the 64 valid taxa reported are new records (46.9 %) and only 33 out of 63 nominal species previously reported are valid (52.4 %). As the present study is still in its early phase, it is expected that more taxa will be found when more habitats are sampled. Evidently our current knowledge of cephalopod fauna of the area does not reflect the true diversity. Reasons for this disparity are examined. Using Taiwan as an example, recommendations are made to improve our knowledge of the cephalopod fauna of the TMMP (Tropical Marine Mollusc Programme) area.

INTRODUCTION

In China and Taiwan, cephalopods are traditionally used and prized as food items with high market value; however, little has been published on these animals in the region. The first record of a cephalopod from Taiwan is that of Berry (1912) when he described *Sepia formosana* from Takao (now known as Kaohsiung). Sasaki (1929) in his monograph listed 18 species of cephalopods belonging to 11 genera in seven families as occurring in Taiwan. Eight species, *ie Sepia tigris*, *Sepiella japonica*, *Euprymna berryi*, *Loligo formosana*, *L. oshimai*, *Abralia multihamata*, *Polypus oshimai,* and *P. luteus*, were described as new to science. Ho (1959) listed ten species of cephalopods belonging to five genera in four families; three of these species were additional to those listed by Sasaki (1929). Tung (1975, 1977, 1978) in a series of articles added another 24 species belonging to 12 genera in eight families. Wu *et al.* (1989) added one species to the Taiwanese fauna and reported eight species belonging to seven genera, five families. In total, these authors reported 42 species of cephalopods in 19 genera belonging to nine families from Taiwanese waters. On a broader geographic scale, Li (1983) recorded 46 species belonging to 19 genera in 12 families from the Taiwan Strait, and Dong (1978, 1988) reported that out of the 79 species of cephalopods from China, 74 species occur in Nan-hai (South China Sea) and 32 species of these also occur in Tong-hai (East China Sea).

The advances in the systematics of cephalopods in recent years have rendered many of these earlier results questionable. Many species names used by these authors have been synonymised. The accuracy of the records of these species in Taiwanese waters cannot be ascertained. In this article I report the result of a systematic study of the cephalopod fauna of Taiwan conducted from January, 1995 intermittently to date, using newly collected material. Forty species of cephalopods belonging to 16 genera in nine families were recorded. Genera newly recorded from Taiwanese waters are *Abraliopsis* and *Cistopus*. Nineteen species are new records for Taiwanese waters, *ie*

Sepia kobiensis, Metasepia pfefferi, Abraliopsis lineata, Octopus aegina (previously recorded as *O. granulatus*), *O. fangsiao, O. cyanea* (previously recorded *as O. marmoratus*), *O. exannulatus, O. marginatus, Cistopus indicus*, two undescribed species of *Hapalochlaena*, and eight additional species of *Octopus,* several of them new to science. Sixteen of the 40 species (in 11 genera and eight families) reported by previous authors were not recorded in this study. This preliminary result together with published records indicated that the cephalopod fauna is speciose.

MATERIALS AND METHODS

Most of the material was purchased in fish markets where catches are unloaded from fishing vessels, where an accurate, albeit general, locality of capture can be ascertained. Other material was captured by bottom trawls using the R.V. Ocean Research No. 3 of the National Sun Yat-Sen University from a range of areas. Species are determined primarily on the basis of morphological characters and live animal attributes, such as colour patterns and skin sculpturing.

Unless otherwise stated, all material studied was fixed in 10 % buffered formalin and preserved in 70 % ethyl alcohol and is lodged in the National Museum of Natural Science, Taichung. Material belonging to the Institute of Zoology of the Academia Sinica, Taipei, and the Peng-Hu Branch of the Taiwan Fishery Research Institute was also studied.

RESULTS

ORDER SEPIIDA

FAMILY SEPIIDAE

Eighteen nominal species have been recorded from Taiwan (Berry 1912; Sasaki 1929; Ho 1959; Tung 1978; Li 1983; Wu *et al.* 1989) prior to this study. They are *Sepia aculeata* Van Hasselt, 1834, *Sepia andreana* Steenstrup, 1875, *Sepia elliptica* Hoyle, 1885, *Sepia esculenta* Hoyle, 1885, *Sepia formosana* Berry, 1912, *Sepia kobiensis* Hoyle, 1885, *Sepia latimanus* Quoy & Gaimard, 1832, *Sepia lycidas* Gray, 1849, *Sepia omani* Adam & Rees, 1966, *Sepia pharaonis* Ehrenberg , 1831, *Sepia prionota* Voss, 1962, *Sepia recurvirostra* Steenstrup, 1875, *Sepia robsoni* Massy, 1927, *Sepia smithi* Hoyle, 1885, *Sepia subaculeata* Sasaki, 1929, *Sepia tigris* Sasaki, 1929, *Metasepia tullbergi* (Appellöf, 1886), *Sepiella japonica* Sasaki, 1929. Of these, *Sepia formosana* and *Sepia tigris* are junior synonyms of *Sepia pharaonis,* and *Sepia subaculeata* is a junior synonym of *Sepia lycidas* (Adam & Rees 1966; Khromov *et al.* 1998). The presence of *Sepia andreana*, *Sepia elliptica*, *Sepia omani*, *Sepia prionota* (= *Sepia papuensis* Hoyle, 1885), *Sepia robsoni*, and *Sepia smithi*, cannot be confirmed by the present study, and the records are probably due to misidentification.

New records are *Sepia vietnamica* Khromov, 1987, *Sepia foliopeza* Okutani & Tagawa, 1987, *Sepia madokai* Adam, 1939, *Sepia* cf. *mestus* Gray, 1849, and *Sepia pardex* Sasaki, 1913, all collected from the northeastern corner of Taiwan. One other species belonging to the *Doratosepion*-group, distinct from *S. andreana* and *Sepia vietnamica,* is also found. Thus, 15 species of sepiids are now known to occur from the waters of Taiwan.

ORDER SEPIOLIDA

FAMILY SEPIOLIDAE

Six nominal species, *ie Sepiola birostrata* Sasaki, 1918, *Inioteuthis japonica* Verrill, 1881, *Euprymna morsei* (Verrill, 1881), *Euprymna berryi* Sasaki, 1929; *Sepiolina nipponensis* (Berry, 1911), and *Austrorossia bipapillata* (Sasaki, 1920), have been recorded from Taiwanese waters (Sasaki 1929; Ho 1959; Tung 1978; Li 1983).

Sepiola birostrata was only recorded by Li (1983) from the Taiwan Strait. Its presence in the waters of the main island of Taiwan or the Penghu Islands (Pescadores) re-

mains to be confirmed. *Euprymna morsei* was recorded from Taiwan by Ho (1959) and Tung (1978). Recently the species has been found to be restricted to the cool temperate waters of Japan (Okutani *et al.* 1987; Okutani & Horita 1987), therefore the records for Taiwan are likely to be the result of misidentification. It is probably referable to *Euprymna berryi* which is abundant in Taiwan and forms small local fisheries. The presence of the remaining four species is confirmed.

FAMILY SEPIADARIIDAE

The genus *Sepiadarium* Steenstrup, 1881 (type species: *S. kochii* from Hong Kong) is well characterised by the complete fusion of the mantle and the base of the funnel, unlike all other sepioliform cuttlefish. The genus is endemic to the western Pacific and was studied by Steenstrup (1881), Berry (1921, 1932), and Adam (1954). Voss (1963) concluded that there are five species (or four species plus one subspecies) in the area. Distribution of most taxa are localised except *S. kochii* Steenstrup, 1881. *Sepiadarium kochii* Steenstrup, 1881 was previously recorded from Taiwan by Tung (1978); the species is found throughout Taiwan.

FAMILY IDIOSEPIIDAE

Idiosepius paradoxa (Ortmann, 1888) has been reported from the South China Sea and the Taiwan Strait (Li 1983). It has not been found in Taiwan and Penghu and is excluded from the fauna list at present.

ORDER TEUTHIDA

SUBORDER MYOPSIDA

FAMILY LOLIGINIDAE

Thirteen nominal species belonging to this family have been reported from this area (Sasaki 1929; Ho 1959; Tung 1977, 1978; Li 1983; Wu *et al.* 1989). They are *Loligo beka* Sasaki, 1929; *Loligo bleekeri* Keferstein, 1866; *Loligo chinensis* Gray, 1849; *Loligo duvaucelii* d'Orbigny, 1835; *Loligo edulis* Hoyle, 1885; *Loligo formosana* Sasaki, 1929; *Loligo gotoi* Sasaki, 1929; *Loligo japonica* Hoyle, 1885; *Loligo kobiensis* Hoyle, 1885; *Loligo oshimai* Sasaki, 1929; *Loligo uyii* Wakiya & Ishikawa, 1921; *Doryteuthis sibogae* Adam, 1954; and *Sepioteuthis lessoniana* Lesson, 1830.

Recent studies reveal that *Loligo formosana* is a junior synonym of *L. chinensis* (Natsukari & Okutani, 1975). *Loligo gotoi* Sasaki, 1929 is synonymous with *L. uyii* (Natsukari, 1983), and *Loligo oshimai* is synonymous with *L. duvaucelii* (Adam, 1954).

The presence of *Loligo bleekeri*, *Loligo japonica*, and *Loligo kobiensis* in Taiwan and Penghu cannot be confirmed by the present study. Using the current nomenclature (Vecchione *et al.* 1998), the seven species of loliginids which are confirmed to occur in Taiwan and Penghu are *Uroteuthis* (*Photololigo*) *chinensis* (Gray, 1849), *Uroteuthis* (*Photololigo*) *duvaucelii* (d'Orbigny, 1835), *Uroteuthis* (*Photololigo*) *edulis* (Hoyle, 1885), *Uroteuthis* (*Photololigo*) *sibogae* (Adam, 1954), *Loliolus* (*Nipponololigo*) *beka* (Sasaki, 1929), *Loliolus* (*Nipponololigo*) *uyii* (Wakiya & Ishikawa, 1921), and *Sepioteuthis lessoniana* Lesson, 1830.

SUBORDER OEGOPSIDA

FAMILY ENOPLOTEUTHIDIDAE

Five species belonging to this family have been reported previously (Sasaki 1929; Tung 1975, 1978; Li 1983; Wu *et al.* 1989). They are *Abralia armata* (Quoy & Gaimard, 1832), *Abralia multihamata* Sasaki, 1929, and *Watasenia scientillans* (Berry, 1911).

The present study confirms the presence of *Abralia multihamata* and records two other species, *Abralia astrostica* Berry, 1909 and *Abraliopsis lineata* (Goodrich, 1896) for the first time in Taiwan. The records for *Abralia armata* and *Watasenia scientillans* are unconfirmed by the present study and may be due to misidentification.

FAMILY PYROTEUTHIDIDAE

Pterygioteuthis giardii Fischer, 1896 has

been captured off the east coast of Taiwan. It is the first record of this species in Taiwan.

FAMILY OMMASTREPHIDAE

Three species of ommastrephids have been recorded from the area (Sasaki 1929; Tung 1975, 1977, 1978; Li 1983; Wu *et al.* 1989). They are *Ommastrephes bartrami* Lesueur, 1821, *Sthenoteuthis oualaniensis* (Lesson, 1830), and *Todarodes pacificus* Steenstrup, 1880. All three species are common at the east coast. *Sthenoteuthis oualaniensis* is also common in the southern waters. Recently *Eucleoteuthis luminosa* (Sasaki, 1915) and *Ornithoteuthis volatilis* (Sasaki, 1915) have been collected for the first time in the waters off the east coast.

FAMILY THYSANOTEUTHIDIDAE

Thysanoteuthis rhombus Troschel, 1857 was reported from the area by Tung (1975, 1978) and Li (1983). Although the species has not been collected in the present study, its occurrence in Taiwanese waters is confirmed by other specimens collected previously. Recently experimental fishing on the species has been conducted and specimens have been captured off the south-east and the east coasts of Taiwan.

FAMILY ONYCHOTEUTHIDIDAE

Onychoteuthis banksii (Leach, 1817) was recorded by Tung (1978) and Li (1983). The species has been collected in the present study off the east coast.

FAMILY CHIROTEUTHIDIDAE

Chiroteuthis imperator Chun, 1908 was captured from the waters off Pingtung in the south west of the island. It is a new record for Taiwan.

FAMILY CRANCHIIDAE

Liocranchia reinhardti (Steenstrup, 1856) has been captured off the Kaohsiung area. It is a new record for Taiwan.

ORDER OCTOPODA

FAMILY OCTOPODIDAE

Fourteen nominal species belonging to this family have been recorded from the waters of Taiwan and Taiwan Strait (Sasaki 1929; Ho 1959; Li 1983; Wu *et al.* 1989; Chang & Chen 1992; Shau & Lin 1993). They are *Octopus* cf. *vulgaris* Lamarck, 1799, *O. berenice* Gray, 1849, *O. bimaculatus* Verrill, 1883, *O. dollfusi* Robson, 1928, *O. fusiformis* Brook, 1887, *O. granulatus* Lamarck, 1799, *O. luteus* (Sasaki, 1929), *O. marmoratus* Hoyle, 1885, *O. ocellatus* Gray, 1849, *O. oshimai* (Sasaki, 1929), *O. ovulum* (Sasaki, 1917), *O. rugosus* (Bosc, 1792), *O. variabilis* (Sasaki, 1929), and *Hapalochlaena maculosa* Hoyle, 1883. Only seven species, *ie Octopus* cf. *vulgaris*, *O. aegina* Gray, 1849 (= *O. granulatus* and *O. dollfusi*), *O. luteus*, *O. cyanea* Gray, 1849 (= *O. marmoratus*), *O. fangsiao* d'Orbigny, 1835 (= *O. ocellatus*), *O. minor* Sasaki, 1920 (= *O. variabilis*), and *Hapalochlaena* cf. *fasciata* non Hoyle, 1885 (= *Hapalochlaena maculosa*, non Hoyle, 1883 in Chang & Chen 1992 and Shau & Lin 1993), can be confirmed by new material. Furthermore, *Cistopus indicus* (Rapp, 1835), *Octopus exannulatus* Norman, 1993, *Octopus marginatus* Taki, 1964, and *Hapalochlaena* cf. *maculosa* (non Hoyle, 1883), a large species with small eggs, distinct from those reported previously, and ten other species of *Octopus* whose identities have yet to be determined, are found. *O. oshimai* was described based on specimens obtained from a fish market in Tainan. Although its occurrence in Taiwan is beyond doubt, it has not been recognized since the original description and at present we are unsure whether it is conspecific with one of the ten unidentified species. It is considered an entity here because of its original record. It is confirmed that at least twenty-one species belonging to this family occur in Taiwan.

FAMILY TREMOCTOPODIDAE

Li (1983) reported *Tremoctopus violaceus* delle Chiaje, 1830 from the Taiwan Strait.

Table 1. Cephalopods described and reported from Taiwan prior to 1994. Source: 1: Berry (1912); 2: Sasaki (1929); 3: Ho (1959); 4: Tung (1975); 5: Tung (1977); 6: Tung (1978); 7: Li (1983); 8: Wu *et al.* (1989); 9: Chang & Chen (1992); 10: Shou & Lin (1993).

Species	Source
FAMILY SEPIIDAE	
Sepia aculeata Van Hasselt, 1834	2,3,6,7
Sepia andreana Steenstrup, 1875	6
Sepia elliptica Hoyle, 1885	7
Sepia esculenta Hoyle, 1885	6,7,8
Sepia formosana Berry, 1912	1,2,3
Sepia kobiensis Hoyle, 1885	7
Sepia latimanus Quoy & Gaimard, 1832	7
Sepia lycidas Gray, 1849	6,7,8
Sepia omani Adam & Rees, 1966	6,7
Sepia pharaonis Ehrenberg, 1831	6,7
Sepia prionota Voss, 1962	6
Sepia recurvirostra Steenstrup, 1875	6,7
Sepia robsoni Massy, 1927	7
Sepia smithi Hoyle, 1885	6
Sepia subaculeata Sasaki, 1929	3
Sepia tigris Sasaki, 1929	2,3
Metasepia tullbergi (Appellöf, 1886)	2,6,7
Sepiella japonica Sasaki, 1929	2,6,7,8
FAMILY SEPIOLIDAE	
Sepiola birostrata Sasaki, 1918	7
Inioteuthis japonica Verrill, 1881	2,6,7
Euprymna berryi Sasaki, 1929	2,7
Euprymna morsei (Verrill, 1881)	3,6
Austrorossia bipapillata (Sakasi, 1929)	6
Sepiolina nipponensis (Berry, 1911)	6
FAMILY SEPIADARIIDAE	
Sepiadarium kochii Steenstrup, 1881	6,7
FAMILY IDIOSEPIIDAE	
Idiosepius paradoxa (Ortmann, 1888)	7
FAMILY LOLIGINIDAE	
Loligo beka Sasaki, 1929	6,7
Loligo bleekeri Keferstein, 1866	7
Loligo chinensis Gray, 1849	5,6,7,8
Loligo duvaucelii d'Orbigny, 1835	6,7
Loligo edulis Hoyle, 1885	3,5,6,7
Loligo formosana Sasaki, 1929	2,3
Loligo gotoi Sasaki, 1929	7
(continued from left column)	
Loligo japonica Hoyle, 1885	6
Loligo kobiensis Hoyle, 1885	6,7
Loligo oshimai Sasaki, 1929	2,3
Loligo uyii Wakiya & Ishikawa, 1921	5,6,7
Doryteuthis sibogae Adam, 1954	5,6,7
Sepioteuthis lessoniana Lesson, 1830	2,3,5,6,7,8
FAMILY ENOPLOTEUTHIDIDAE	
Abralia armata (Quoy & Gaimard, 1832)	6
Abralia multihamata Sasaki, 1929	2,4,7
Watasenia scientillans (Berry, 1911)	8
FAMILY OMMASTREPHIDAE	
Ommastrephes bartrami Lesueur, 1821	2,6,7
Sthenoteuthis oualaniensis (Lesson, 1830)	2,4,5,6,7
Todarodes pacificus Steenstrup, 1880	4,5,6,7,8
FAMILY THYSANOTEUTHIDIDAE	
Thysanoteuthis rhombus Troschel, 1857	4,6,7
FAMILY ONYCHOTEUTHIDIDAE	
Onychoteuthis banksii (Leach, 1817)	6,7
FAMILY OCTOPODIDAE	
Octopus cf. *vulgaris* Lamarck, 1799	2,3,7,8
Octopus berenice Gray, 1849	7
Octopus bimaculatus Verrill, 1883	7
Octopus dollfusi Robson, 1928	7
Octopus fusiformis Brook, 1887	7
Octopus granulatus Lamarck, 1799	2
Octopus luteus (Sasaki, 1929)	2,7
Octopus marmoratus Hoyle, 1885	2
Octopus ocellatus Gray, 1849	7
Octopus oshimai (Sasaki, 1929)	2,7
Octopus ovulum (Sasaki, 1917)	7
Octopus rugosus (Bosc, 1792)	7
Octopus variabilis (Sasaki, 1929)	7
Hapalochlaena maculosa (non Hoyle, 1883)	9,10
FAMILY TREMOCTOPODIDAE	
Tremoctopus violaceus delle Chiaje, 1830	7
FAMILY ARGONAUTIDIDAE	
Argonauta hians Solander, 1786	7

The species has been collected from the east coast of Taiwan.

FAMILY ARGONAUTIDAE

Li (1983) recorded *Argonauta hians* Solander, 1786 from the Taiwan Strait. The species has been collected from the south coast of Taiwan. An immature male specimen of *Argonauta* sp. has also been collected from the east coast of Taiwan.

DISCUSSION

Prior to this study, 63 species belonging to 19 genera in 9 families had been reported from the Taiwanese waters (Tab. 1). Several of these species are junior synonyms of other valid species and some others are of dubious identification, *eg Sepia prionota*, *Sepia smithi,* and *Euprymna morsei*. None of the voucher specimens of these records were available for study to verify the identification.

The present study records 64 species belonging to 28 genera in 14 families (Tab. 2). Only 32 species are in common with previous reports. At least 30 species are newly

Table 2. Cephalopods known to occur in Taiwan. Source: 1: Berry (1912); 2: Sasaki (1929); 3: Ho (1959); 4: Tung (1975); 5: Tung (1977); 6: Tung (1978); 7: Li (1983); 8: Wu *et al.* (1989); p: present study.

Species	Source
FAMILY SEPIIDAE	
Sepia aculeata Van Hasselt, 1834	2,3,6,7,p
Sepia esculenta Hoyle, 1885	6,7,8,p
Sepia foliopeza Okutani & Tagawa, 1987	p
Sepia kobiensis Hoyle, 1885	7,p
Sepia latimanus Quoy & Gaimard, 1832	7,p
Sepia lycidas Gray, 1849	6,7,8,p
Sepia madokai Adam, 1939	p
Sepia cf. *mestus* Gray, 1849	p
Sepia pardex Sasaki, 1913	p
Sepia pharaonis Ehrenberg, 1831	6,7,p
Sepia recurvirostra Steenstrup, 1875	6,7,p
Sepia (*Doratosepion*) sp. TW 1	p
Sepia vietnamica Khromov, 1987	p
Metasepia tullbergi (Appellöf, 1886)	2,6,7,p
Sepiella japonica Sasaki, 1929	2,6,7,8,p
FAMILY SEPIOLIDAE	
Inioteuthis japonica Verrill, 1881	2,6,7,p
Euprymna berryi Sasaki, 1929	2,7,p
Austrorossia bipapillata (Sasaki, 1929)	6,p
Sepiolina nipponensis (Berry, 1911)	6,p
FAMILY SEPIADARIIDAE	
Sepiadarium kochii Steenstrup, 1881	6,7,p
FAMILY LOLIGINIDAE	
Loliolus (*Nipponololigo*) *beka* (Sasaki, 1929)	6,7,p
Loliolus (*Nipponololigo*) *uyii* (Wakiya & Ishikawa, 1921)	5,6,7,p
Uroteuthis (*Photololigo*) *chinensis* (Gray, 1849)	5,6,7,8,p
Uroteuthis (*Photololigo*) *duvaucelii* (d'Orbigny, 1835)	6,7,p
Uroteuthis (*Photololigo*) *edulis* (Hoyle, 1885)	3,5,6,7,p
Uroteuthis (*Photololigo*) *sibogae* (Adam, 1954)	5,6,7,p
Sepioteuthis lessoniana Lesson, 1830	2,3,5,6,7,8,p
FAMILY ENOPLOTEUTHIDIDAE	
Abralia multihamata Sasaki, 1929	2,4,7,p
Abralia astrostica Berry, 1909	p
Abraliopsis lineata (Goodrich, 1896)	p
FAMILY PYROTEUTHIDIDAE	
Pterygioteuthis giardii Fischer, 1896	p

Species	Source
(continued from left column)	
FAMILY OMMASTREPHIDAE	
Ommastrephes bartrami Lesueur, 1821	2,6,7,p
Sthenoteuthis oualaniensis (Lesson, 1830)	2,4,5,6,7,p
Todarodes pacificus Steenstrup, 1880	4,5,6,7,8,p
Eucleoteuthis luminosa (Sasaki, 1915)	p
Ornithoteuthis volatilis (Sasaki, 1915)	p
FAMILY THYSANOTEUTHIDIDAE	
Thysanoteuthis rhombus Troschel, 1857	4,6,7
FAMILY ONYCHOTEUTHIDIDAE	
Onychoteuthis banksii (Leach, 1817)	6,7,p
FAMILY CHIROTEUTHIDIDAE	
Chiroteuthis imperator Chun, 1908	p
FAMILY CRANCHIIDAE	
Liocranchia reinhardti (Steenstrup, 1856)	p
FAMILY OCTOPODIDAE	
Octopus cf. *vulgaris* Lamarck, 1799	2,3,7,8,p
Octopus aegina Gray, 1849	p
Octopus cyanea Gray, 1849	p
Octopus exannulatus Norman, 1993	p
Octopus fangsiao d'Orbigny, 1835	p
Octopus luteus (Sasaki, 1929)	2,7,p
Octopus marginatus Taki, 1964	p
Octopus minor (Sasaki, 1920)	2,7,p
Octopus oshimai (Sasaki, 1929)	2
Cistopus indicus (Rapp, 1835)	p
Hapalochlaena cf. *fasciata* (Hoyle, 1886)	p
Hapalochlaena cf. *maculosa* non Hoyle, 1883	p
Octopus sp. TW 1	p
Octopus sp. TW 5	p
Octopus sp. TW 6	p
Octopus sp. TW 7	p
Octopus sp. TW 8	p
Octopus sp. TW 9	p
Octopus sp. TW 10	p
Octopus sp. TW 11	p
Octopus sp. TW 12	p
Octopus sp. TW 13	p
FAMILY TREMOCTOPODIDAE	
Tremoctopus violaceus delle Chiaje, 1830	7,p
FAMILY ARGONAUTIDAE	
Argonauta hians Solander, 1786	7,p

recorded from Taiwanese waters: *Sepia foliopeza*, *Sepia* (*Doratosepion*) *kobiensis*, *Sepia madokai*, *Sepia* cf. *mestus*, *Sepia pardex*, *Sepia* (*Doratosepion*) sp. TW 1, *Sepia vietnamica*, *Abralia astrostica*, *Abraliopsis lineata*, *Eucleoteuthis luminosa*, *Chiroteuthis imperator*, *Liocranchia reinhardti*, *Octopus aegina* (previously recorded as *O. granulatus*), *O. fangsiao* (previously recorded as *O. ocellatus*), *O. cyanea* (previously recorded as *O. marmoratus*), *O. exannulatus*, *O. marginatus*, *Cistopus indicus*, *Hapalochlaena* cf. *fasciata* (previously recorded as *Hapalochlaena maculosa*), *H.* cf. *maculosa*, and *Octopus* species TW 1, TW 5, TW 6, TW 7, TW 8, TW 9, TW10, TW11, TW12, and TW 13. *Octopus* sp. TW 8 may be conspecific with *Octopus kagoshimensis* Ortmann, 1888. *Hapalochlaena* cf. *fasciata*, *H.* cf. *maculosa*, and some of the species designated as *Octopus* species TW 1, TW 5, TW 6, TW 7, TW 9, TW 10, TW 11, TW 12, and TW 13 may be

new to science. Further studies, with additional material in some cases, are needed to properly describe and name these species.

The present study indicates that the cephalopod fauna of Taiwan is speciose as the study only covers those species that are obtainable in fish markets. Those species that are not sold in the market place and those in offshore waters are not included. The fauna is complex. It includes species of temperate affinity and species of tropical affinity. When comparing the present result with previous reports, it is evident that the proportion of newly recorded taxa is large. Thirty out of the 64 valid taxa reported are new records (46.9 %) and only 33 out of the 63 nominal species previously reported are valid (52.4 %). As the present study is still in its early phase, many habitat types have not been sampled. It is expected that more taxa will be found when more habitats are sampled. Evidently our current knowledge of cephalopod fauna of the area does not reflect the true diversity of the fauna. This is due to several reasons:

1. Lack of regional expertise resulting in a lack of thorough regional faunal treatment and misidentification: Despite the importance of cephalopods in the diet of the people and to the economy, there has never been a resident expert worker on the taxonomy of cephalopods. Several works on cephalopods of Taiwan have been published over the years, these are either simplified faunal lists without any voucher specimens or are on fisheries biology of some species with fisheries importance. Sasaki's (1929) work remains the only taxonomic treatment of the Taiwanese cephalopods. This has resulted in misidentification and lumping of names.

2. Lack of adequate samples in good condition with accurate collection data: Adequate collections by trawlers or research vessels with accurate position determining instruments have not been easily obtainable. Specimen samples for taxonomic purposes are often obtained from fish markets in which cases collection position and environmental data are seldom available. Although it is possible to ascertain if the specimens were captured locally or from the nearby area, it is impossible to ascertain the position or even the general area accurately. Such materials are of limited value in determining distribution of a species. Specimens obtained from fish markets are necessarily biased in favour of species with higher market value, *ie* of good culinary quality and larger size. Small species or small specimens of larger species are seldom available. Poorly preserved material is an impediment to accurate identification, hence the poor taxonomy. Previously frozen specimens obtained from fish markets often result in distorted preserved specimens. For good preserved specimens it is necessary that the specimens are freshly caught and acquired soon after.

3. Lack of voucher collection from previous studies: In most cases, the voucher specimens of previous studies have not been kept. The result is that verification of the original identification is impossible. For species whose Taiwanese records appear to be outside of the normal geographical distribution, it is impossible to verify the validity of the records until new material is collected.

SUGGESTIONS FOR IMPROVING TAXONOMIC KNOWLEDGE ON CEPHALOPODS IN THE TMMP AREA

The poor state of the taxonomic knowledge of cephalopods in Taiwan clearly does not coincide with the economic importance of the group in the region. The same is true for the study area of the TMMP (Tropical Marine Mollusc Programme), mainly in the South China Sea and the Andaman Sea.

The «International Workshop on the biology and resource potential of cephalopods» held in Melbourne, Australia in 1981 made a series of recommendations regarding future research on cephalopods covering the fields of Systematics and Morphology, Ecology and General Biology, and Life Cycles and

Culture (Roper *et al.* 1983). These recommendations remain relevant and valid. Norman & Lu (submitted) recommended three processes to redress the poor state of the taxonomy of cephalopods in the South China Sea area. They are:

* Extensive alpha taxonomy is required to describe (and produce an inventory of) all taxa present in this region, including development of detailed and "user-friendly" keys to this fauna.

* Inter-country collaboration on both initial surveys and ongoing monitoring.

* Support for, and development of, regional expertise. These measures are applicable to the TMMP area.

Additionally, several specific actions are recommended here:

* Increase the scope and improve the quality of regional collections.

* Conducting regular regional workshops on the taxonomy and identification of cephalopods.

* Exchange of excess identified specimens.

* Collaboration between scientists of the region in taxonomic research on cephalopods.

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